GROUND-WATER RESOURCES OF RICHLAND COUNTY, SOUTH CAROLINA

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

LAND, WATER AND CONSERVATION DIVISION

WATER RESOURCES REPORT 30

2003

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by

Roy Newcome, Jr.

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GROUND-WATER RESOURCES OF RICHLAND COUNTY, SOUTH CAROLINA
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ABSTRACT

Richland County, in central South Carolina, obtains nearly all of its public and industrial water supplies from the City of Columbia water system, which processes 62 million gallons per day from the Broad River at Columbia and Lake Murray on the Saluda River just west of the city.

The Fall Line, on which Columbia is located, divides the county's physiography and hydrogeology into two parts. The northwestern third is in the Piedmont, with its igneous and metamorphic bedrock exposed; and the remainder is in the Coastal Plain, which comprises sand-and-clay formations. Ground-water availability and quality in the two areas are greatly different.

In the bedrock area, water wells generally are several hundred feet deep and have low yields, commonly less than 10 gallons per minute. The water is usually alkaline, moderate in total mineralization, and hard. In contrast, wells in the Coastal Plain aquifers are capable of much larger yields—depending on location, as much as 2,000 gallons per minute. The water is acidic, extremely low in mineral content, and has almost no hardness; it frequently is within the range of rainwater's chemical quality.

Wells in the bedrock are widely used for domestic water supplies in the northwestern part of Richland County. Of more than 900 wells drilled in the county in the years 2001-02, one-third were bedrock wells.

Wells in the Coastal Plain sediments are used for domestic and small-irrigation supplies and, in the southern end of the county, for industrial supplies. In the Eastover area, several large industrial and farm-irrigation wells pump 2,000 gallons per minute or more. The county, below the Fall Line, has considerable additional ground-water supply potential. Its development is somewhat restricted, in places, by exceedingly deep water levels that reduce the drawdown available to wells in certain aquifer zones.

INTRODUCTION

Location and Geography

Richland County, irregular in shape and 772 square miles in area, lies in central South Carolina (Fig. 1). It contains the State Capitol, at Columbia; therefore, it is the center of State and Federal government. It also has numerous industries and substantial areas in forests and crop land. Fort Jackson, the U.S. Army's largest basic-training facility, occupies 52,000 acres in the central part of the county; it is included in Columbia's eastern city limit.

Bounded by latitude 33º 45' and 34º 16' N. and longitude 80º 36' and 81º 21' W., the county is about 100 miles from Charleston and Greenville, to the southeast and northwest, respectively, and the same distance south of Charlotte, N.C. Augusta, Ga., is 70 miles to the southwest, Savannah is 150 miles south, and Atlanta is 200 miles to the west. These cities are connected with Columbia via Interstate Highways 20, 26, 77, or 95. Richland's neighboring counties are Fairfield (north), Kershaw and Sumter (east), Calhoun (south), and Lexington (west). A 3½-mile boundary with Newberry County exists at the northwest extremity of Richland County.

The topography of the county is hilly in the northwest where bedrock is at the surface, flat and swampy in the river valleys on the eastern and southwestern margins of the county, and gently to moderately rolling elsewhere. Elevations range from 570 ft (feet) above sea level near Blythewood to 80 ft along the Congaree and Wateree Rivers at the southeast corner of the county. Much of Columbia is in the 250-350 ft range in elevation. Complete topographic-map coverage is available for the county in the form of 25 7.5-minute topographic quadrangles published by the U.S. Geological Survey (Fig. 1).

The Fall Line, where crystalline rocks of the Piedmont physiographic province meet the Coastal Plain sand-and-clay formations, trends irregularly through the northwestern part of the county (Fig. 1). The Piedmont rocks are exposed above the Fall Line in about one-third of the county and underlie the rest of the county at increasing depth southeastward. At the coast, these rocks are covered by as much as 4,000 ft of younger deposits of sand, clay, and limestone.

Climate

The climate of Richland County is characterized as humid subtropical. Summers are long and hot, winters are short and mild, and springs and falls are very pleasant transition periods. The average summer temperature is 80.5 ºF and the average winter temperature is 48.6 ºF. Temperatures rarely exceed 100 ºF or drop below 20 ºF. July is usually the hottest month and January the coldest. The growing season is 8 months in length.

A long-term rainfall average of 45 inches has been established for the county, but the recent drought (1998-2002) has produced a marked variation from the average. In normal years the rainfall is well distributed, with July the wettest month and October the driest (5.54 and 2.56 inches, respectively).

Snow is infrequent and of short duration. Storms associated with Atlantic and Gulf hurricanes occasionally bring heavy rain and wind to the county. Hurricane Hugo (1989) caused damage to trees, property, and electric service, but this was an unusual occurrence.

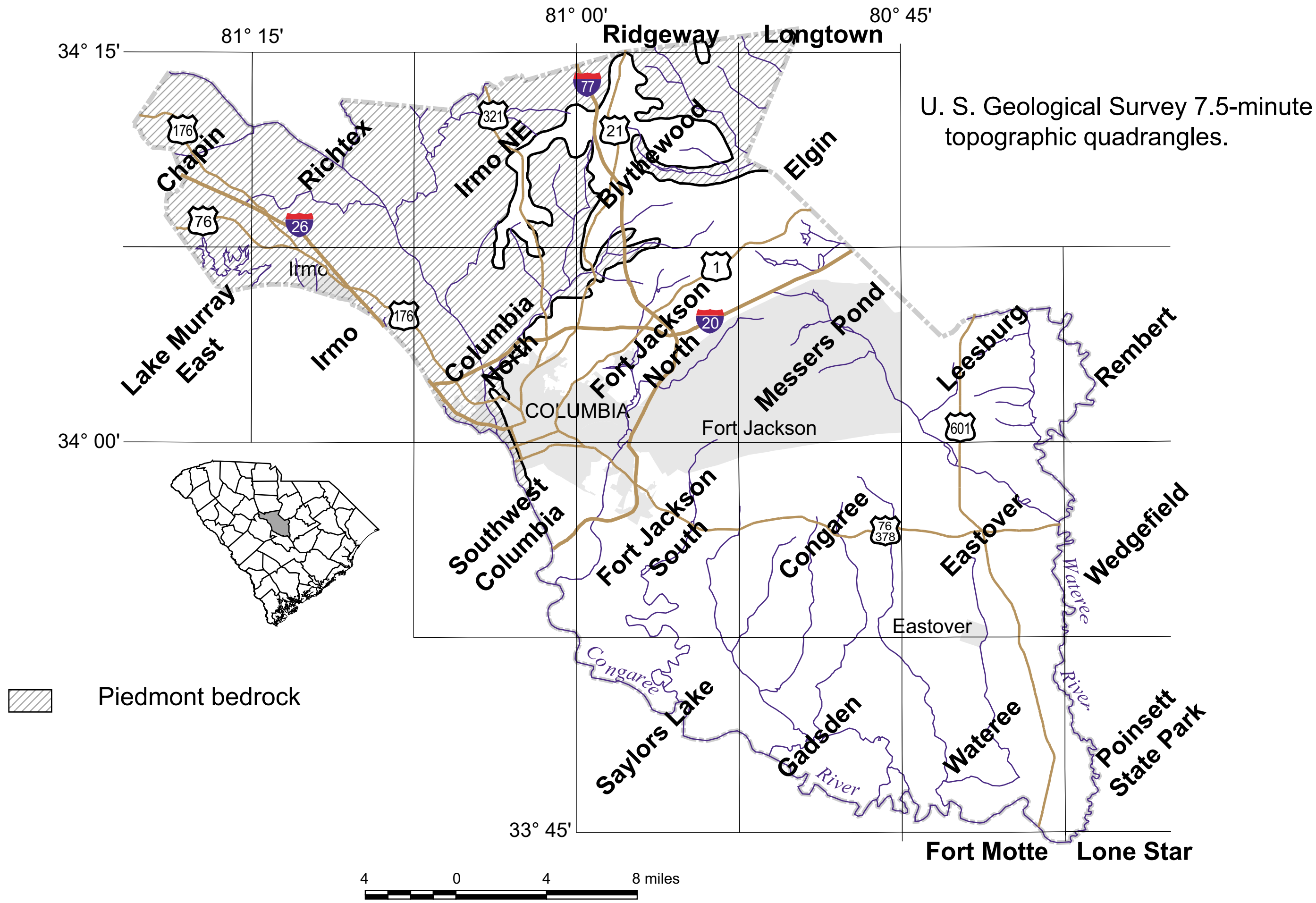


Figure 1. Location and topographic-map coverage of Richland County, S.C.

Population and Development

Richland County is South Carolina's second-most populous county at 320,677 (2000 U.S. Census), an increase of 12 percent since 1990. Most of the population is in Columbia and its environs, the largest of which is the U.S. Army's Fort Jackson with an average population of about 20,000 soldiers and their families. Recruit training at that facility processes 40,000 soldiers per year.

More than 200 industries in the county employ about 17,000 people. The largest are Westinghouse Electric Corp. and Bose Corporation (1,300 and 850 employees, respectively). Insurance and banking concerns are major commercial employers. Blue Cross and Blue Shield of South Carolina has 6,000 people. State, Federal (civilian), city, and county governments account for about 74,000 employees in the Columbia metropolitan area (U.S. Bureau of Labor Statistics).

Agriculture is only moderately important in Richland County, where there are 57,000 acres of farmland (11½ percent of county). Major crops are soybeans, wheat, hay, and corn. About 1,000 acres are irrigated. Forests cover 330,660 acres (67 percent of county) and include 23,350 acres of reserved old-growth land, such as Congaree Swamp National Monument. The acreages reported here were supplied by representatives of the South Carolina Department of Agriculture and the South Carolina Forestry Commission.

Water Supply

The two municipal water systems in Richland County serve the city of Columbia and the town of Eastover. Columbia pumps an average of 62 mgd (million gallons per day) from the Broad River Canal (34 mgd) and Lake Murray (28 mgd). Eastover's pumpage is about 0.1 mgd and is obtained from wells. Fort Jackson purchases about 2.5 mgd from Columbia.

Most industries in Richland County are on Columbia's water system, but a few have their own wells. Notable among these is the International Paper Co. mill near Eastover, which has the largest industrial well-water supply in the county. IP pumps 2 mgd for use in its processes.

Purpose and Scope of Report

Richland is one of the few Coastal Plain counties that have not had their ground-water resources described in other than regional reports. Although the county is blessed with excellent sources of water supply in its rivers—Saluda, Broad, and Wateree—and in nearby Lake Murray (on the Saluda), there are ground-water resources of great current and potential value available for all types of use.

This report endeavors to show where the ground water is, how much can be obtained from wells, and what is known of its chemical quality. The sources of this information are well records, geophysical logs, pumping tests, and chemical analyses in the files of the South Carolina Department of Natural Resources (DNR).

Many of the records are drillers' reports of water wells. Such reports are required by law to be filed with the South Carolina Department of Health and Environmental Control (DHEC).

HYDROGEOLOGIC SETTING

Ground water in Richland County is obtained from two types of aquifers: (1) the crystalline bedrock of Paleozoic age (500 million years) that is exposed in the northwestern third of the county and underlies the rest of the county; and (2) Cretaceous-age (100 million years) sand beds of the Coastal Plain formations southeast of the Fall Line.

Piedmont Rocks

In the bedrock, the water is restricted to cracks and crevices of random depth and extent. The mechanics of recharge to the bedrock aquifers of the South Carolina Piedmont were well stated by Mitchell (1995) in his report on ground water in Greenville County. In describing the hydrologic relationship of the hard but fractured bedrock and the overlying weathered portion (saprolite), he said "The overlying weathered bedrock, saprolite, ranges in thickness from 0 to 100 ft or more, but it averages about 60 ft. This clayey mantle has high porosity but low transmissivity. As such, it serves as a storage reservoir for the water infiltrating from precipitation. Underlying the saprolite is the unweathered bedrock, which can serve as a water reservoir if it is substantially fractured. Fractures in the bedrock act as conduits carrying water from the overlying saprolite. There is a transitional zone between the two units that varies from inches to several feet in thickness. Rarely is the contact between saprolite and bedrock sharp and absolute, but rather there is a gradual lessening of the weathering effects and an increase in competency of the bedrock. Where the gradation from saprolite to bedrock is sharp and occurs over a short vertical distance, the boundary is often itself a source of ground water. Where there are few fractures or a scarcity of water in the fractures, the transition zone is sometimes the only viable source of water." The foregoing applies generally to the bedrock and saprolite in Richland County.

Water in the bedrock is under confined (artesian) conditions—that is, it is under pressure in the rock crevices and rises in wells, often hundreds of feet. Flowing wells are practically unknown, however. The map of Figure 2 shows the area of bedrock exposure and contours on its buried surface.

Coastal Plain Sediments

Sand-and-clay formations of Cretaceous and Tertiary ages that overlie the crystalline bedrock constitute the Coastal Plain sediments, which thicken from zero at the Fall Line to 650 ft at the southeast corner of Richland County where the bedrock surface is about 700 ft below sea level. These sediments are overlain, in turn, by 25 to 50 ft of Pleistocene terrace material

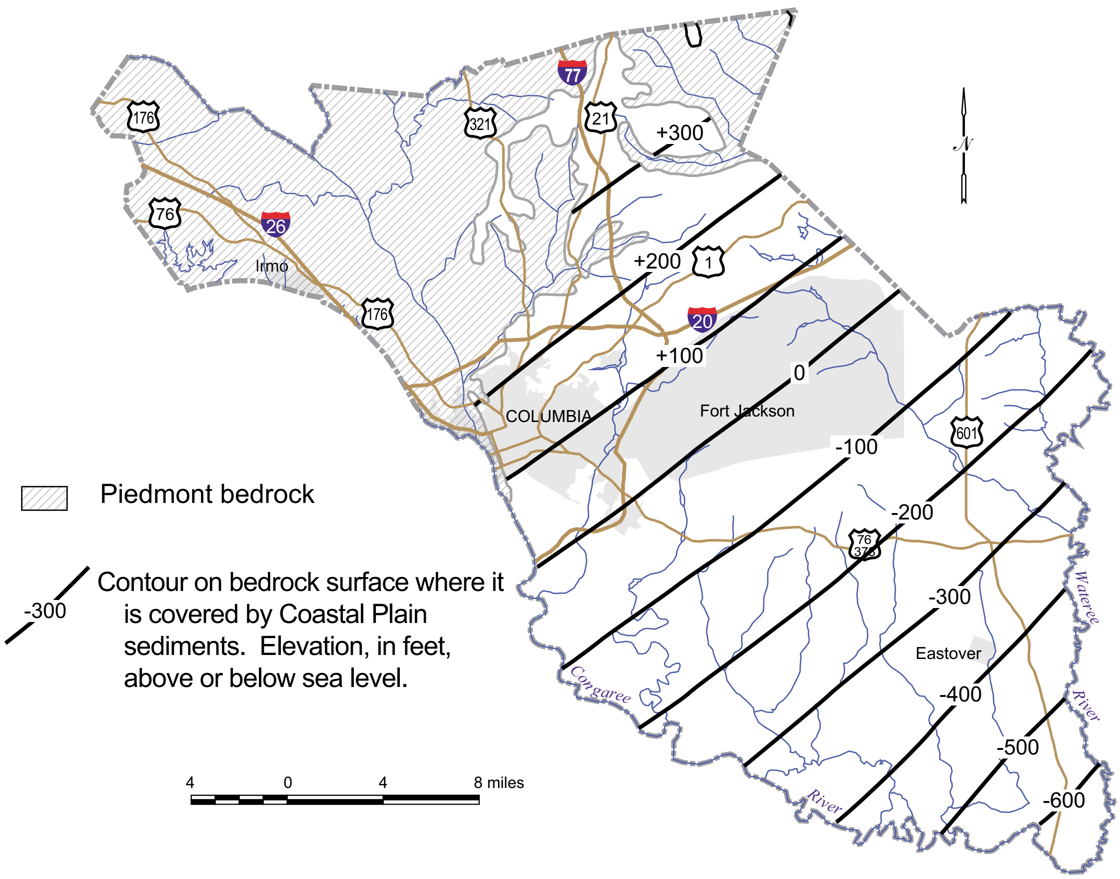


Figure 2. Approximate contours on the top of bedrock where it is covered by Coastal Plain sediments in Richland County.

in much of southern Richland County or by river alluvium in the Congaree and Wateree River valleys, the latter 50 ft or so in thickness where the two rivers join to form the Santee River.

Rainfall on outcrops of the sand aquifers maintains the water table and recharges those aquifers as they dip beneath clay confining beds. The terraces are, primarily, catchment areas that drain rapidly into the aquifers beneath or adjacent to them or out onto the surface drainageways.

The geologic map of Figure 3 provides a generalized expression of the formations in Richland County. Sand beds, irregular in thickness and extent, in the Upper Cretaceous and Tertiary formations constitute the aquifers southeast of the Fall Line. Foremost among these sources of supply for water wells are the Cretaceous-age Middendorf and Black Creek Formations. Less-important sources are the Black Mingo Formation (Paleocene) and the Congaree Formation (Eocene). The latter two units are thin and of limited areal extent in southern Richland County.

Water wells range in depth from less than 50 ft to 600 ft, and although most wells are designed to satisfy only domestic and lawn-irrigation needs (15-20 gallons per minute), large industrial wells produce as much as 2,000 gpm, and a yield of 2,250 gpm is reported for a farm-irrigation well.

Drainage

Richland County is part of a complex drainage system. The Broad and Saluda Rivers join at Columbia to form the Congaree River, and this system drains nearly three-quarters of the county (Fig. 4). The remainder, on the eastern side, is drained by the Wateree River. All of the foregoing drainage coalesces at the southeastern tip of the county to form the Santee River. The Santee then flows through Lake Marion and empties into the Atlantic Ocean near McClellanville in Charleston County. Lake Murray, on the Saluda River just upstream from Columbia, is mostly in Lexington County, but it is of great value to Richland County. It is the source of nearly half of Columbia's water supply, and its real-estate and recreational value is very important to the local economy.

The basic southeasterly drainage pattern of ground water in Richland County is locally distorted by the alluviated valleys of the Congaree and Wateree Rivers. As a result, the water in

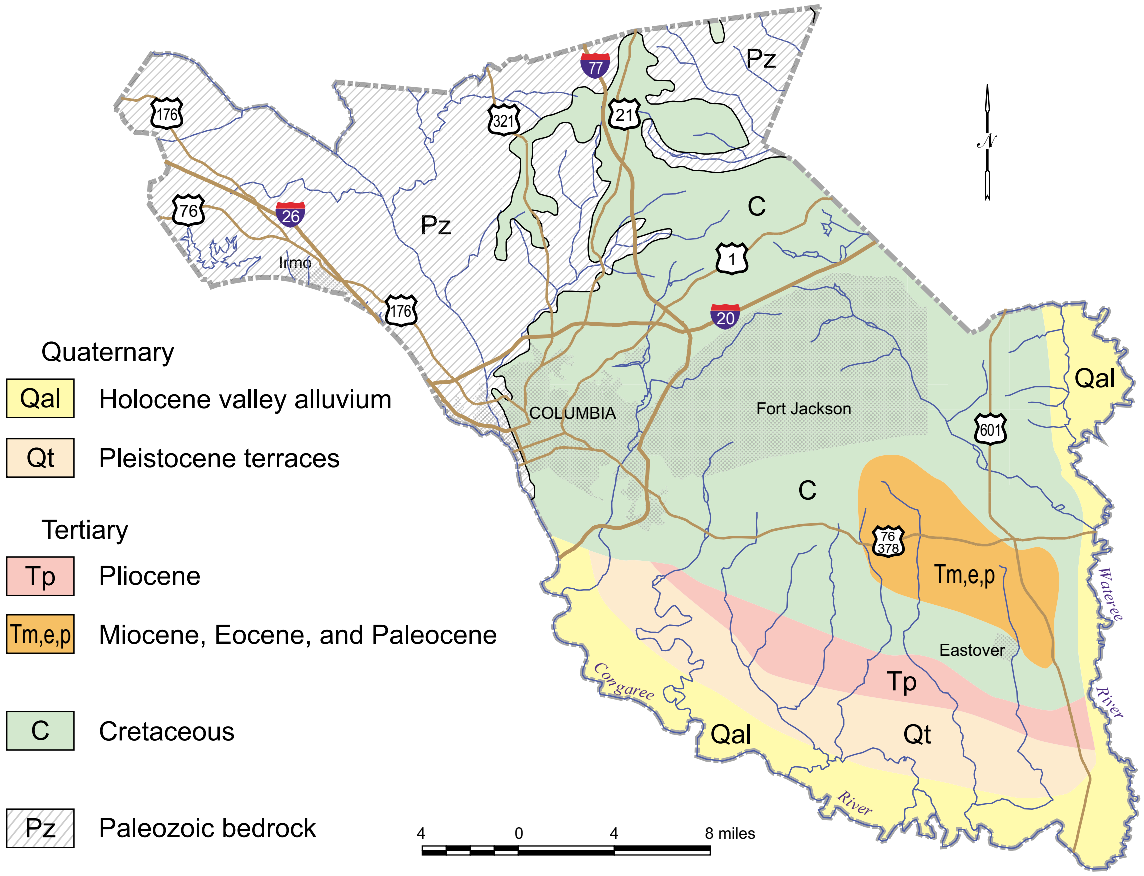


Figure 3. Generalized areal geology of Richland County (After Maybin and Nystrom, 1995).

the shallow Coastal Plain aquifers flows eastward toward the Wateree River and southwestward toward the Congaree, as well as southeastward down the dip of the aquifer system.

Further complicating the flow pattern is the multitude of recharge sites at various elevations. In these places, rainfall percolates downward into the near-surface permeable material and thence into the aquifers, the movement controlled by the hydrostatic head in the sandy zones. The result is sometimes widely differing water levels at various depths in the same area, or even in the same well.

WATER WELLS

Rock Wells

One-third of the wells drilled in Richland County in 2001-02 were completed in bedrock. Their depths ranged from 100 to 1,005 ft. Some of these wells penetrated Coastal Plain sediments and, in a few extreme cases, nearly 1,000 ft of rock. Of the 300-plus rock wells drilled, two-thirds were less than 400 ft deep. All of them were constructed with 6-inch casing, usually to a depth less than 100 ft, with the hole open below that depth. Water levels in half the wells were less than 40 ft below the land surface, and well yields were generally less than 20 gpm; more than half were less than 10 gpm.

Reported yields must be looked at with caution, as they may not truly reflect the well's capacity. A 6-inch well holds 1½ gallons per foot of its length. The interval between the well's static (nonpumping) water level and the pump setting represents a reservoir that may support, for a limited time, withdrawal far exceeding the well's intake from the aquifer.

Sand Wells

Approximately 660 wells were completed in sand beds of the Cretaceous-age and younger formations in 2001-02. In depth they ranged from about 50 ft to 300 ft, half being 100 ft or shallower. Nearly all of them had 4-inch casing and were constructed with 20 ft of screen opposite the aquifer. These wells—with few exceptions—are used for domestic or lawn-irrigation supplies. Water levels are less than 40 ft deep in nearly half the wells, but more than 80 ft in a fifth of them.

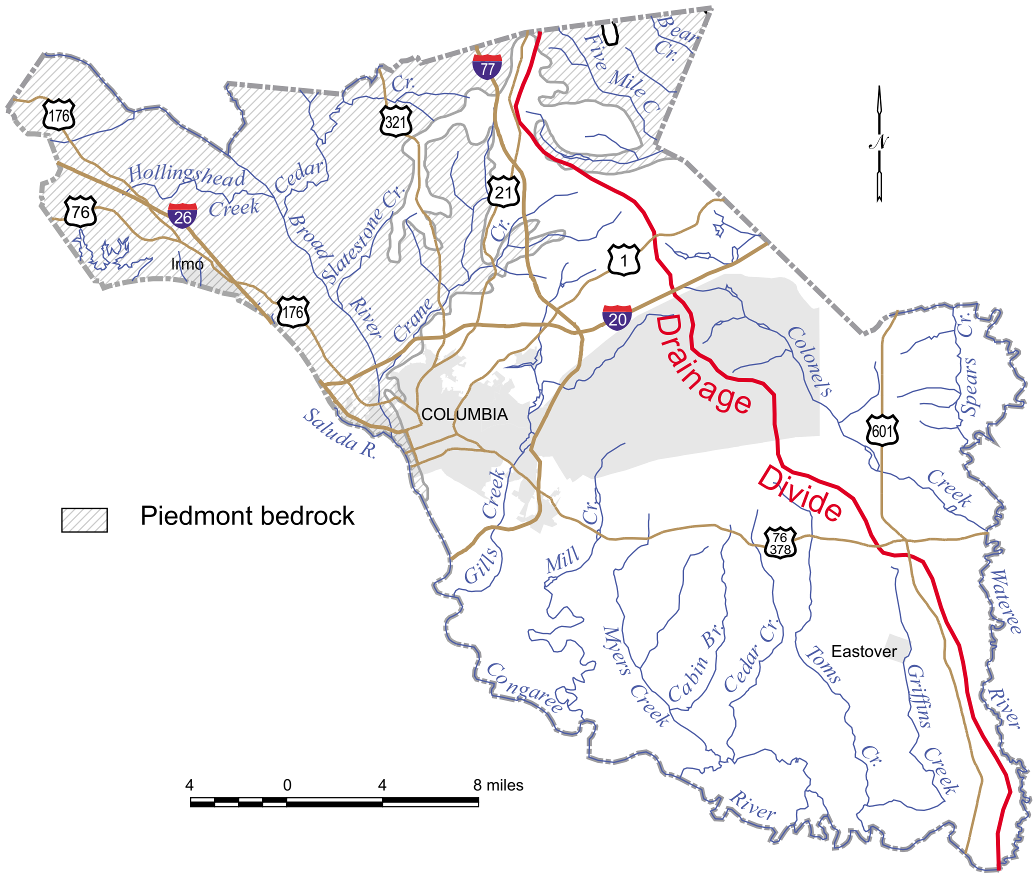


Figure 4. Surface drainage in Richland County.

The wells are usually pumped at 20 gpm or less, although several produce more than 50 gpm, the greatest being 100 gpm at Spring Valley High School northeast of Columbia.

Although no large wells were constructed in Richland County in 2001-02, some very large industrial-supply and farm-irrigation wells are operating in the southern part of Richland County where the sand aquifers are thickest and available drawdown (distance between the static water level and the top of the well screen) is sufficient to support yields greater than 2,000 gpm.

A limiting feature of the sand wells, in places, is a deep static water level (100-200 ft). Perhaps the relatively low topographic relief just south of the Fall Line, where some of the lower beds of the Middendorf Formation crop out and receive their recharge, is responsible for those beds having insufficient pressure to lift the water within the commonly expected 30-40 ft below the land surface. Consequently, there may locally be little available drawdown, which greatly restricts the well yields. In 2001-02, a quarter of the sand wells drilled in Richland County had water levels below the top of the aquifer in which they were screened. This means that water-table conditions (no artesian pressure) prevail in these basal aquifers of the Middendorf Formation, while at the same location shallower sand beds that are recharged at higher elevations contain water under confined (artesian) conditions and rise in wells. In the water-table situation, available drawdown becomes the distance between the water table and the well screen.

The medium that produces the just-described anomalous situation is the irregular but widespread kaolinitic clay that occurs in numerous lenticular beds which separate and confine the sand beds. In nearly every well, the drillers report alternating beds of sand and “chalk”or “white clay.” This material is almost pure kaolin and is an effective barrier to water movement between sand beds. Another possible, but unproven, cause of the local water-table conditions in the basal Middendorf sand is leakage into cracks in the underlying bedrock or into its saprolite (weathered rock) mantle. Ordinarily, the artesian pressure in the rock aquifers is sufficient to prevent downward leakage from the overlying clastic aquifers, but this may not hold true for the saprolite or even for minor bedrock fractures. Figure 5 is an idealized

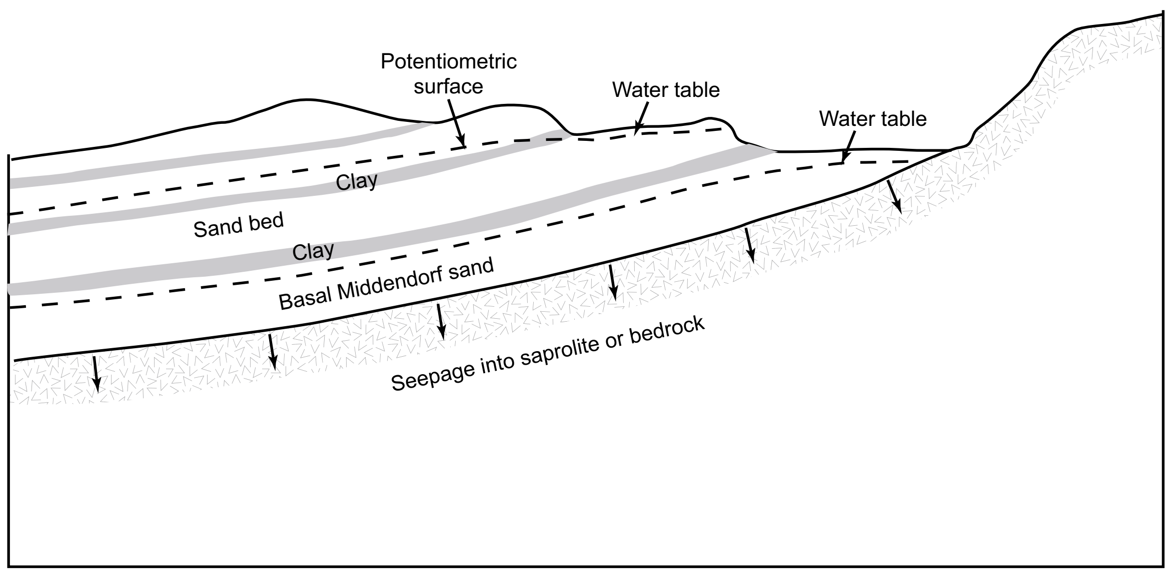


Figure 5. Idealized diagram illustrating a deep water-table aquifer with a higher confined aquifer in the same locality.

diagram illustrating the situation hypothesized above. Investigation of these concepts is needed to permit better understanding of the hydraulics of aquifers near the Fall Line.

The likelihood of a rock well's capacity being overstated because of available storage in the well is matched, in reverse, by a sand aquifer's capacity to yield water being underestimated. Because the majority of sand wells are constructed to supply only domestic or lawn-irrigation needs, in the 15-25 gpm range, it might be assumed that this small yield is all that is available. In fact, where the available drawdown is in the "normal" range (static water level less than 40 ft below land surface and the top of the well screen deeper than 80 ft), a properly constructed well might yield 50 to 2,000 gpm, depending on the aquifer transmissivity. The largest wells this writer knows to have been tested in Richland County are at the Eastover mill of the International Paper Co. The best of three 2,000-gpm wells had an available drawdown of 410 ft but required only 67 ft of drawdown to produce the stated yield, thus the specific capacity of the well was 30 gpm per foot of drawdown. Figure 6 shows the interrelations of available drawdown, specific capacity, and well yield. Specific capacity, of course, is a function of the aquifer transmissivity, which is discussed in a later section.

Well Numbering

Wells in DNR files have county numbers assigned sequentially as their records are obtained, as RIC-58. They also are given a number in the South Carolina Well-Grid System that locates the wells to the nearest minute of latitude and longitude and assigns a sequential number within that minute. Thus, RIC-58 has the grid number 26Q-x1, which would place it near the southeast corner of the county, as may be seen on Figure 7.

AQUIFER AND WELL HYDRAULICS

Aquifer hydraulics and well hydraulics are so interrelated that a discussion of them separately would have little practical value. The linking factor is *specific capacity,* which is the well yield for each foot of water-level drawdown in a well. It is usually expressed in gallons per minute per foot of drawdown for a 1-day period, and, as stated earlier, it is a function of aquifer transmissivity. It is, however, greatly affected by well efficiency and variously affected by the degree of aquifer penetration by the well screen (in the sand-aquifer situation) and by the magnitude of the aquifer storage coefficient.

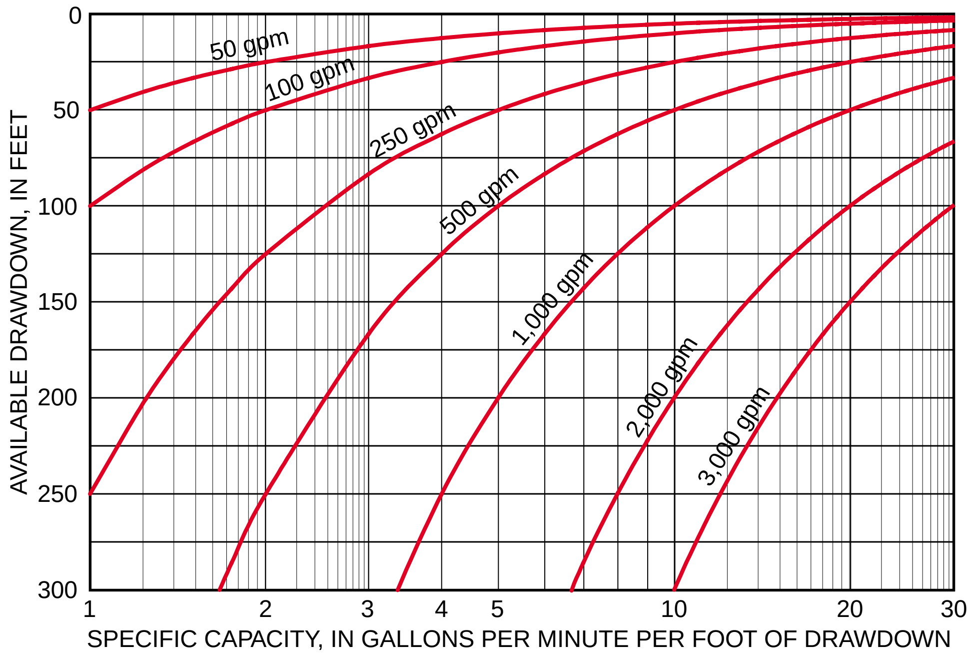


Figure 6. Well yields for various specific capacities and available drawdowns.

In the rock aquifers, none of the foregoing properties and conditions are likely to have much significance, and specific capacity typically is very low, usually producing a severe drawdown even in a low-yield well. For the sand aquifers, on the other hand, well efficiency and aquifer penetration are controllable and involve critical design and construction decisions to obtain the most water at the least cost. Storage coefficient is the reflection of a natural property that cannot be controlled, but for the confined aquifers in our region of interest, field pumping tests indicate it to be in the range of 0.0001-0.0005. These are typical values for confined aquifers and imply little difference in practical effects.

The two factors of overriding importance, well efficiency and aquifer penetration, require careful attention. Since in the order of accomplishment the setting of screen in a sand aquifer comes first, it will be considered first here, but the selection of the size of screen openings is so critical to well efficiency that the two factors are inseparable.

Selection of an aquifer to be screened is based on a driller's log or an electric log, or both. The length of well screen is selected by the driller or engineer, as is the size of the screen's openings. Figure 8 shows the relation between the percentage of aquifer screened and the percentage of available water. For example, if 50 percent of the aquifer is screened, the well could be expected to produce in the neighborhood of 65-90 percent (depending on aquifer thickness) of the amount it could produce if the aquifer were fully screened. Worth considering also is the placement of several short screens throughout a thick aquifer—to obtain most of the available well production at a screen-cost savings.

In selecting screen openings, it is imperative to have representative sand samples for analysis to determine the proper gravel size if a gravel envelope is to be used. The gravel should be sized to the aquifer and the screen sized to the gravel. Each should permit passage of the requisite percentage of the aquifer material, so that after development the well will produce the maximum amount of water with the minimum loss of head in the well's vicinity. This is *well efficiency,* a critical element in well performance that has a pronounced influence on the cost of pumping water. Figure 9 illustrates the effect of different well efficiencies, the ideal condition being that shown in well A where there is little or no head loss in moving water from the aquifer into the well. At well B, twice as much pumping lift is required to produce the same amount of water at the surface because of the head loss at the well face.

For pumping tests made on sand wells in and near Richland County, well efficiencies ranged from 100 percent down to 20 percent, with a median value of 65 percent. It is the opinion of this writer that every well should be at least 70-percent efficient. Proper selection of well screens and gravel envelopes, followed by thorough well development, should greatly enhance the efficiency and thereby reduce the pumping costs of wells in sand aquifers.

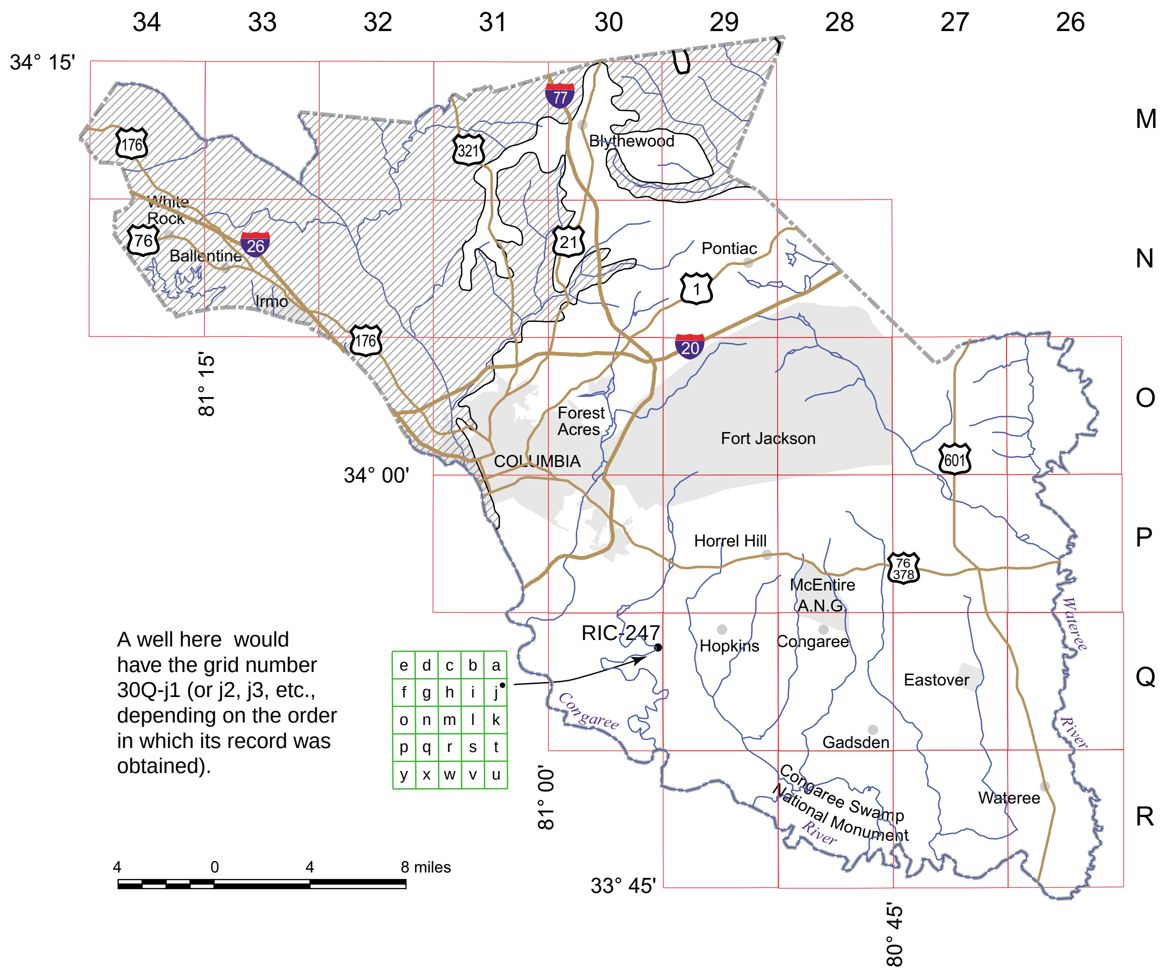


Figure 7. South Carolina well-grid system.

The numerical relationship of well specific capacity and aquifer transmissivity is illustrated by the graph in Figure 10. This graph reveals also that for aquifer conditions nearer to unconfined, or water-table (storage coefficient higher), the specific capacity is greater for a given transmissivity. Further, it is apparent on the graph that doubling the well diameter increases the specific capacity by only 10 percent.

Transmissivity

Pumping tests of 19 wells in Richland County (16 sand wells and 3 rock wells) show transmissivities (T) of 3,700 to 65,000 gpd/ft (gallons per day per foot of aquifer width under unit hydraulic gradient) for the sand wells and 150 to 5,000 gpd/ft for the rock wells (Table 1). See the footnote. The high sand well T values are from tests in the southern part of the county where Middendorf sand beds are thick and deep compared to those in the updip area. Pumping tests of 27 sand wells in adjacent counties, but near the Richland County line, provided T values of 2,900 to 98,000 gpd/ft, with a median of 21,000. This compares with a median T of 14,000 gpd/ft for the 15 tests in Richland County. The farther downdip one proceeds from the Fall Line, the thicker will be the section of Coastal Plain sediments and, with that, the likelihood of thicker aquifers that often, but not always, have high transmissivity. T values for the rock aquifers are generally low; three tests in adjacent Lexington County provided questionable T's of 32, 38, and 1,100 gpd/ft.

The usefulness of aquifer T cannot be overstated. From it can be calculated: (1) the specific capacity, and hence the yield, that can be expected from wells; (2) the magnitude of interference between wells for any given time, distance, and pumping rate; and (3) the hydraulic conductivity (K) of the aquifer. The last-named property (K) is of value in estimating T where a pumping test is not available. K is obtained by dividing T by the aquifer thickness, and K can then be applied, at least in the general area, to the thickness as indicated by electric logs or drillers' logs to arrive at a T value and thus shrink the "unknown" in water supply planning.

Footnote: Readers who prefer to express transmissivity (T) in feet squared per day may divide the T values in this report by 7.48.

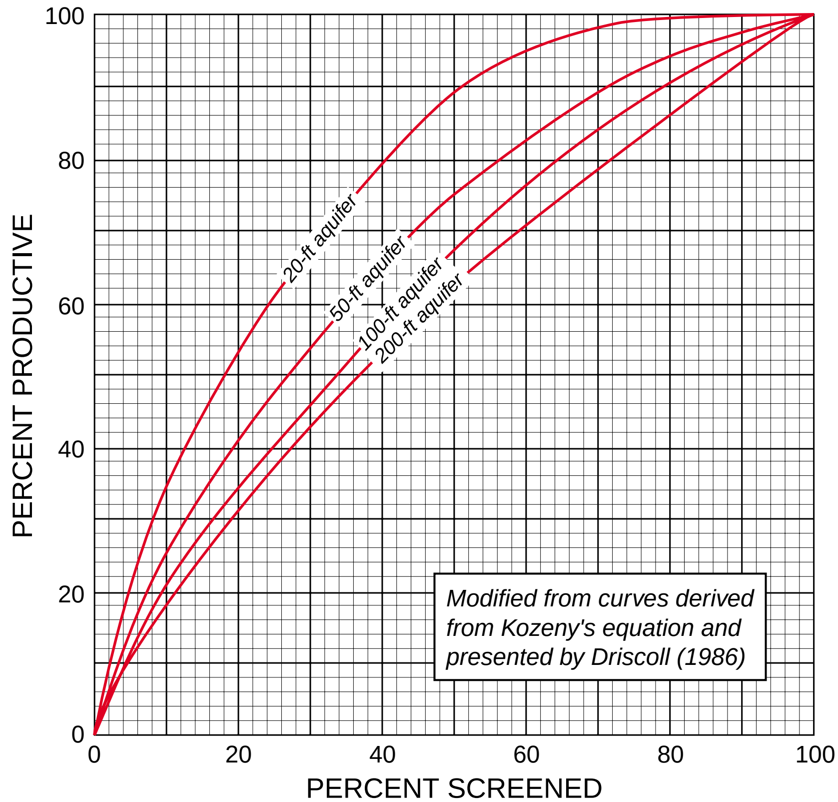


Figure 8. Relation of screened interval to potential well productivity for various aquifer thicknesses and a 12-inch well diameter.

The reader should understand that the T values in Table 1 are not meant to imply that all the sand beds at any site were tested; the test results usually represent one or more selected aquifers, but rarely every available one.

Artesian Versus Water-Table Conditions

Bedrock aquifers—A typical rock well obtains its water from one or more fractures or fracture zones that may have been developed and enlarged by subsurface weathering. The water is almost always under pressure—that is, the rock containing the fractures confines the water, thus it rises in wells that penetrate the fractures. Pumps in rock wells usually lower the water level substantially while pumping, even at low rates. The water level may be lowered below the fracture zone or zones. Consequently, the pressure in the fractures is relieved at the well and for some distance away from the well, at least until pumping ceases and the water returns to its static level. Water cascading down the face of the well and undergoing aeration may be subjected to chemical changes that can result in solution or precipitation of minerals on the well face and in the water. This can have an undesirable effect on water quality.

Sand aquifers—The three-quarters of sand wells that are completed in aquifers having static water levels many feet above the top of the aquifer, and in which the pumping water level is not lowered below that point, are artesian wells. A significant number of wells that are artesian at rest are converted to water-table conditions when pumping lowers their water level below the aquifer top. The hydraulic effect of this is an increase in specific capacity (gallons per minute per foot of drawdown) that accompanies the shift from confined (artesian) conditions with a low aquifer storage coefficient (example 0.0002) to unconfined (water-table) conditions with a high storage coefficient (example 0.1). With a T of 20,000 gpd/ft, a 12-inch diameter artesian well would have a specific capacity of 9.5 gpm/ft of drawdown whereas a water-table well would have a specific capacity of 15 gpm/ft. It follows, then, that the negative effect of having limited available drawdown is offset somewhat by the increase in specific capacity that occurs when the water level falls below the top of the aquifer.

For the sand aquifers that have water levels below the aquifer top, the situation is the water-table type. A quarter of the sand wells drilled in Richland County in 2001-02 are of this type. In the Hopkins-Eastover area, especially, many

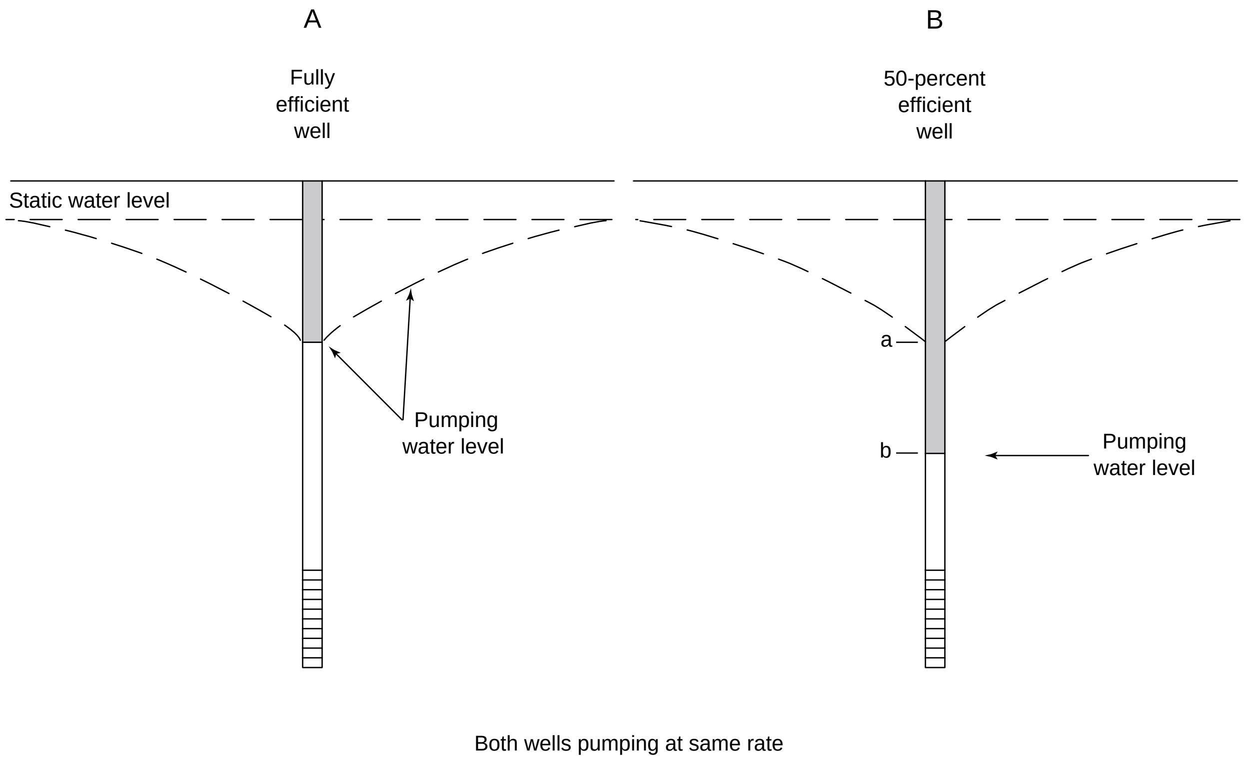


Figure 9. Illustration of the effect of well inefficiency (ab is additional pumping lift).

residential wells have deep static water levels (some more than 200 ft). At the same time, that area contains some large-capacity and much deeper wells (2,000 gpm, 550 ft) that have static water levels less than 100 ft below the land surface. The water-level elevation differences are not explained by topographic differences.

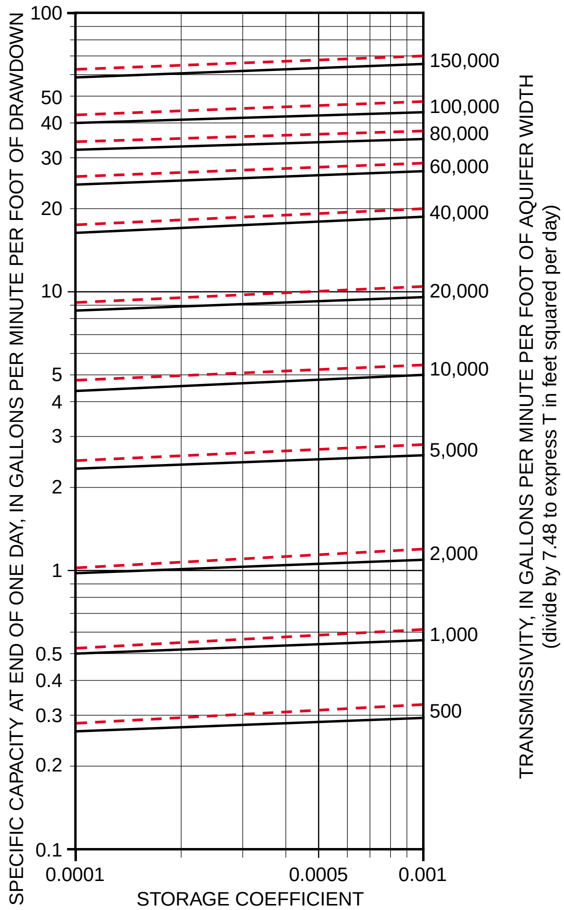
A comparison of well depths and water levels in the sand-aquifer wells suggests the relations shown in the following table. The deepest water level reported for 532 sand wells drilled in 2001-02 was 235 ft, and this was for a 278-ft well.

Range in well depth (ft)	Range in water level (ft)
80-100	20-60
100-160	40-100
160-250	80-180
250-320	140-235
500-600	20-40

The setting of screens and pumps in sand wells should always take into consideration the distance between the static water level and the top of the well screen (available drawdown). It is desirable, for physical, chemical, and biological reasons, to have the pumping level within the available-drawdown range. Where it is necessary to draw water levels below the aquifer top, they should at least be maintained above the screen.

Pumping Effects

Pumping from large-capacity wells, such as public-supply, industrial, and irrigation wells, can lower areal, or even regional, water levels for the aquifer. With knowledge of the aquifer properties (transmissivity and storage coefficient), the drawdown effects at any combination of pumping rate, distance, and time can be calculated. This has been done in the graphs of Figure 11a,b for a general range of T that includes most of the values determined in pumping tests in Richland and Kershaw Counties (see Newcome, 2002). For T values not shown on these graphs, the drawdown effects may be interpolated approximately. For other pumping rates the effects are directly proportional.



To obtain the specific capacity, find the transmissivity value indicated by the pumping test, follow the appropriate well-diameter line to its intersection with the calculated or assumed storage-coefficient line, and then read horizontally to the left margin. All scales are logarithmic, and this should be considered when interpolating for other values of transmissivity.

This chart is for the normal range of confined-aquifer storage coefficients. It is based on the well being 100-percent efficient.

This chart is adapted from one presented by R. R. Meyer in USGS Water-Supply Paper 1536-I in 1963.

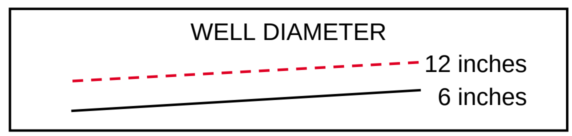


Figure 10. Interrelation of transmissivity, storage coefficient, well size, and specific capacity (from Newcome, 1997).

Drawdown effects can be minimized by (1) institution of a pumping schedule that interrupts discharge and thus permits some recovery of water levels or (2) interception of a recharge source by the spreading cone of water-level depression caused by pumping. The recharge source could be an abrupt thickening of the aquifer or increase in its T, or it could be a surface-water body. The effect would be a reduction in the slope of the drawdown graph (water level vs. time) after the recharge source is tapped.

Drawdown effects can be increased by (1) the pumping of other wells in the aquifer or (2) the pumping cone of depression encountering a discharge boundary. The latter could be an abrupt thinning or pinching-out of the aquifer or decrease in its T, or it could be a geologic fault that has offset the aquifer. The effect would be a steepening of the slope of the drawdown graph after the boundary is encountered.

The reader is cautioned here to not expect a large representation of either a recharge or discharge effect unless it occurs early in the pumping period (the first few hours).

SAND INTERVALS ON ELECTRIC LOGS

Electric logs provide the best means of defining sand intervals in boreholes. Differences in the electrical resistance and spontaneous-potential of sand, clay, and rock are recorded as graphs that indicate the types of material penetrated throughout the borehole depth (Fig. 12). Along with the driller's log and samples of the material penetrated, the electric log will guide the engineer or driller in where best to set well screen in order to obtain the most water. The electric log can also be used as an indicator of water quality. The magnitude of the electrical resistivity of a water-bearing sand bed is largely reflective of the concentration of dissolved mineral matter in the water. The less mineralized the water is, the more resistance there is to the electrical impulse; thus, the greater deflection of the resistance curve. Figure 12 also shows the static-water-level elevations for several nearby wells for which the producing aquifers are indicated on the electric log.

Table 1. Results of pumping tests in Richland County, S.C. (modified from Newcome, 2000b)

County well number	S. C. grid number	Location	Electric log	Depth (ft)	Aquifer thickness (ft)	Date of test	Duration (hr) (dd/recov)	Static water level (ft)	Pumping rate (gpm)	Transmissivity (gpd/ft)	Storage coefficient	Specific capacity (gpm/ft)	Well efficiency (percent)
SAND WELLS													
RIC-52	27Q-l3	Eastover (water tank)		112	50	4/28/1976	2/2	31	120	10,000		3.2	65
RIC-62	26R-c2	Eastover, 4 1/2 mi SE	X	549	110	10/15/1974	24/8	24	2,000	65,000	0.0002	30	90
RIC-63	26R-c1	Eastover, 4 1/2 mi SE	X	547	100	8/6/1974	24/20	23	2,000	59,000		22	75
RIC-301	26W-x2	Eastover, 3 3/4 mi SE	X	250		3/1970	9/	65	524	19,000		4.4	45
RIC-450	26W-g1	Eastover, 3 mi ENE	X	604	185	11/2/1982	24/12	87	1,507	57,000	0.0005	24	85
RIC-452	26Q-g2	Eastover, 3 mi ENE	X	584	170	7/29/1982	24/7	97	192	45,000		9.1	40
RIC-502	29N-h2	Pontiac, 1 1/2 mi NW		135	19	8/21/1985	2.5/2	70	14	4,800	0.0001	1.9	85
RIC-506	29N-p1	Pontiac, 3 1/2 mi SW	X	130	50	7/2/1986	4/2.5	65	150	21,000		5.7	55
RIC-508	29N-p3	Pontiac, 3 mi WSW		222		3/19/1986	4/4	125	25	1,200		0.6	100
RIC-511	30N-t3	Pontiac, 3 3/4 mi WSW		180		3/7/1986	4/4	109	22	11,000		1.6	30
RIC-525	30N-k1	Pontiac, 3 1/2 mi WSW	X	100	30	8/7/1988	2/9	71	26	14,000		4.1	60
RIC-532	28P-q5	Horrell Hill, 1 1/2 mi E	X	269	60	4/1990	24/6	34	240	5,800		2.3	80
RIC-586	26Q-g4	Eastover, 1 1/2 mi ENE	X	540		8/28/1990	24/19	93	2,000	62,000		18	60
RIC-612	29N-q2	Spring Valley High School	X	233	55	5/2/2001	12/	140	100	6,600		3.3	100
RIC-613	28Q-s1	Gadsden Park	X	240	35	6/7/2001	24/0.5	29	24	3,700		1.2	65
ROCK WELLS													
RIC-449	31O-v2	Columbia, downtown	X	360		8/17/1983	12/2	48	20	150		0.1	100
RIC-601	34N-i3	White Rock		120		9/1979	24/	35	47	1,370		<1	100?
RIC-603	31O-k9	Columbia, north edge		360		4/1/1996	73/24	22	175	5,000		4.5	100

Although transmissivity is given here in gallons per day per foot of aquifer width, it is frequently reported in feet squared per day; the latter can be obtained by dividing the former by 7.48, the number of gallons in a cubic foot.

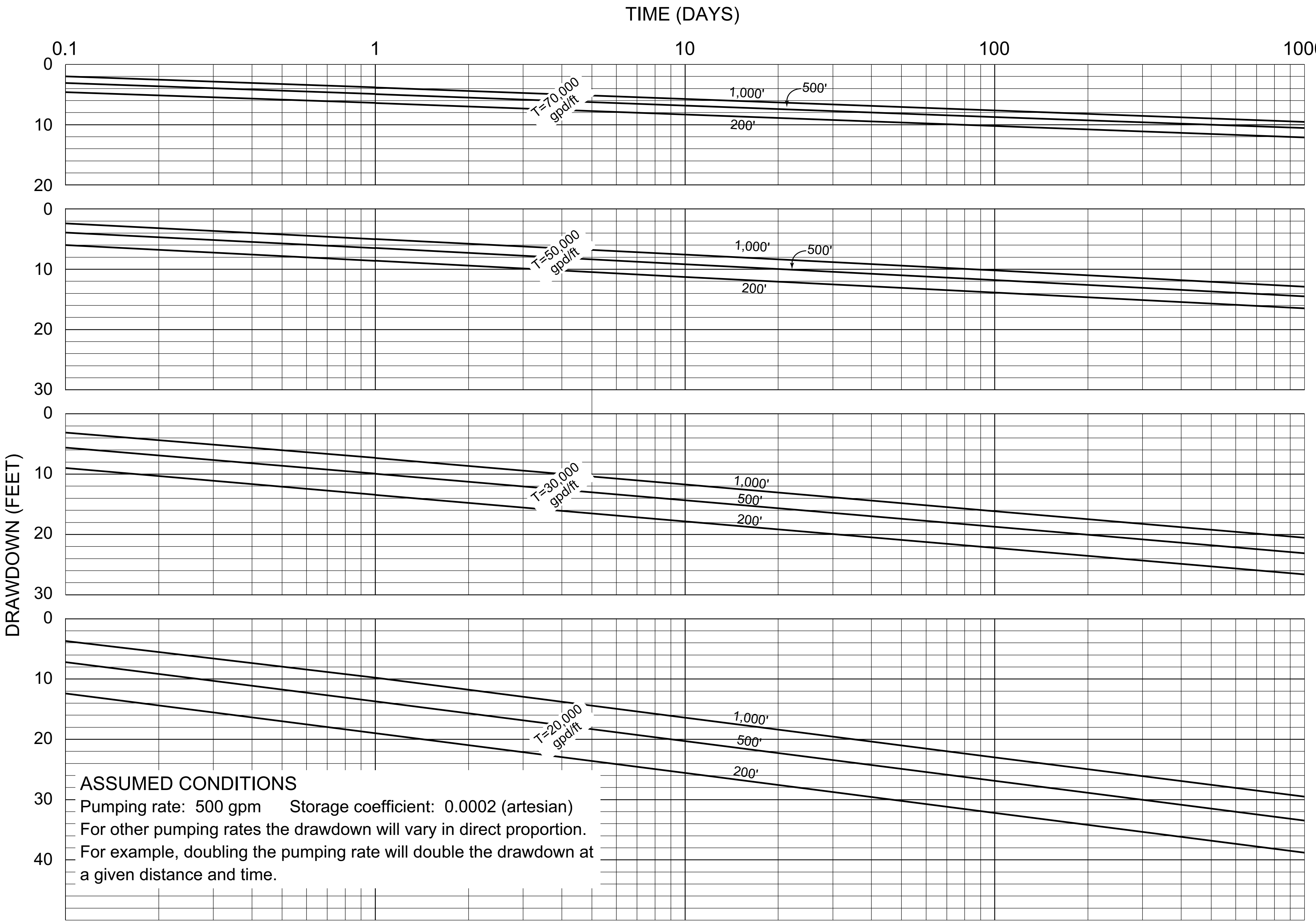


Figure 11a. Predicted pumping effects at various distances and times for the Cretaceous aquifers in Richland County. Transmissivities of 20,000 to 70,000 gpd/ft and a pumping rate of 500 gpm (from Newcome, 2002).

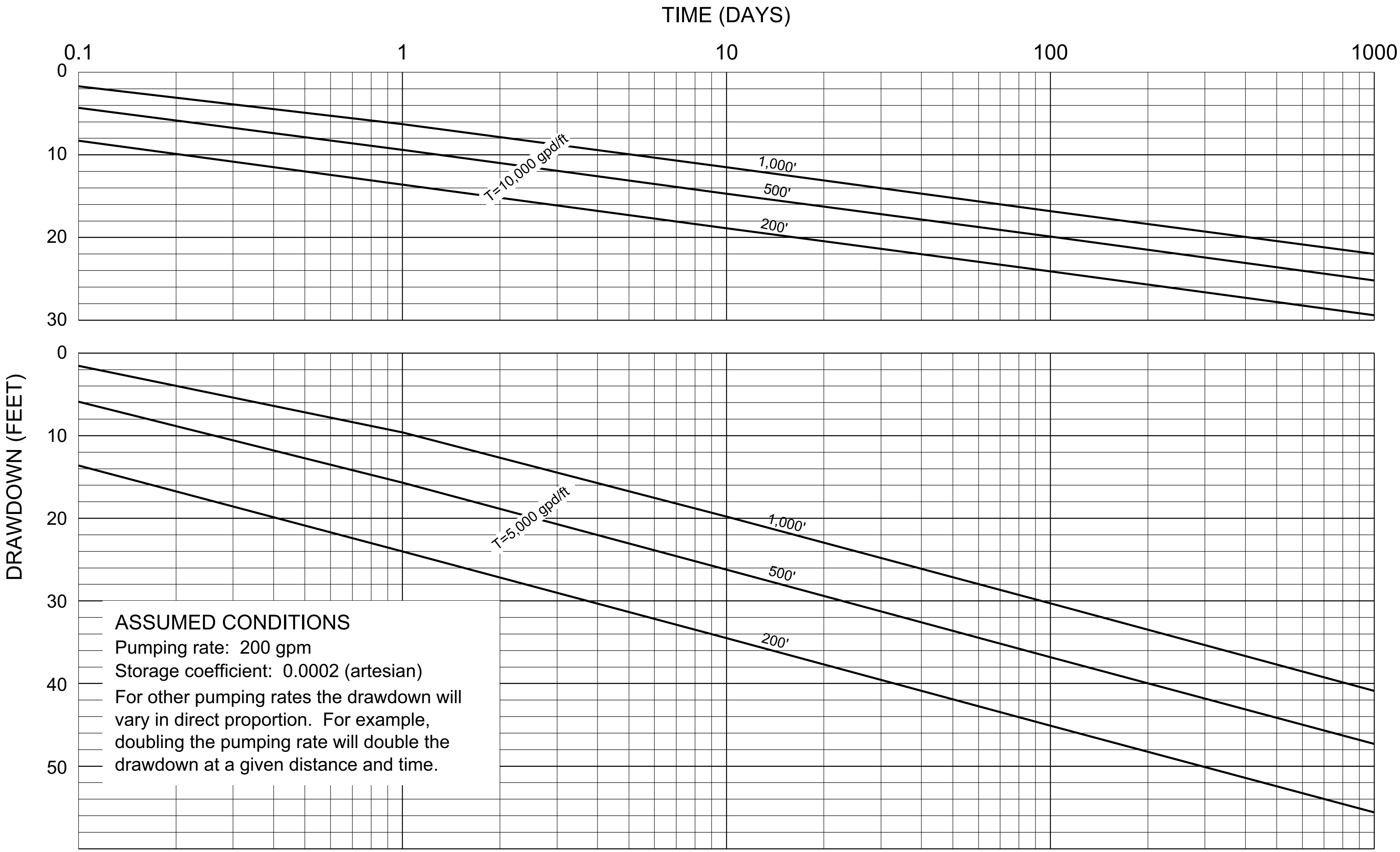


Figure 11b. Predicted pumping effects at various distances and times for the Cretaceous aquifers in Richland County. Transmissivities of 5,000 and 10,000 gpd/ft and a pumping rate of 200 gpm (from Newcome, 2002).

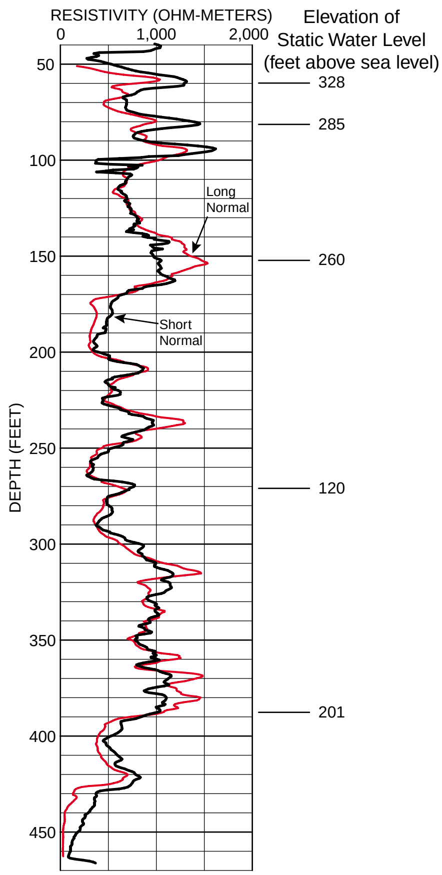


Figure 12. Electric log of a core hole at Horrell Hill (RIC-585), with elevations of static water levels in nearby wells. Resistivity deflections to the right indicate sand beds. Land-surface elevation is 320 ft.

Table 2 contains a listing of sand intervals indicated by electric logs of 27 wells in and near Richland County. Locations of these logs are shown on Figure 13. Because the sand beds generally are irregular in thickness, correlation of individual beds over distance can be difficult. A bed that is massive at a site may be broken into several thinner beds by clay layers within a mile or less. Usually, sufficient correlation of generally sandy sections can be achieved to guide the water seeker.

POTENTIAL YIELDS OF WELLS

This writer knows of no means by which the potential yield of a rock well can be reliably estimated. Water in the rock aquifers truly is "where you find it." Occasionally we are surprised by a 100-gpm rock well, but it is much more normal to see yields below 10 gpm.

The potential yield of a well in a sand aquifer is determined by the thickness and hydraulic conductivity of the aquifer and the well's available drawdown. The actual yield achieved is dependent on these factors and, further, on the well diameter and degree of penetration (screened interval) and on the well efficiency.

Sand thicknesses among the 27 electric logs listed in Table 2 ranged from 4 to 305 ft, and half of them exceeded 40 ft. Hydraulic conductivity indicated by the pumping tests in Richland County ranged from 100 to 600 gpd/ft^2 and had a median value of 260 gpd/ft^2. The foregoing suggests a median transmissivity of about 10,000 gpd/ft. Such a T would provide a fully efficient well with a specific capacity of 5 gpm per foot of drawdown. Again calculating with median values from the nearly 600 sand wells drilled in 2001-02, a depth of 65 ft to the top of the aquifer and a water level of 45 ft would provide at least 20 ft of available drawdown. Thus, a 100-gpm well (20x5) should be obtainable where all parameters conform to the median. This, of course, is merely an exercise, but it illustrates how the various controlling factors come together to estimate potential well yields.

As would be expected, the largest well yields—present and potential—are in the southern part of the county. Here, the Cretaceous section is thickest (650 ft), as are the sand aquifers it contains. See Table 2 and Figure 13. The most productive wells in operation at this writing are at the International Paper Co. plant near Eastover and the Godspeed Farm near Wateree, where yields of 2,000 gpm or more are obtained from wells in the 550-600 ft depth range. It is almost certain that yields greater than 3,000 gpm can be obtained here.

In the part of Richland County between the Fall Line and the southeastern area, there is considerable variety in aquifer depth and thickness and, therefore, in potential yields of wells. Figure 14 presents a generalized areal distribution of the potential yields of wells in the sand aquifers. This map is based on an examination of electric logs and pumping-test findings in Richland County and nearby portions of Kershaw, Sumter, and Calhoun Counties. The reader should keep in mind that although a locality may have substantial aquifers, unless there is adequate available drawdown, the full potential of the aquifers is not achievable. What we seek is a deep, thick aquifer with a shallow static water level.

WATER QUALITY

The chemical quality of water obtained from wells in Richland County ranges from excellent to poor but is generally good. There are major differences in chemical composition between water in the rock aquifers and that in the sand aquifers. These differences are evident in the chemical analyses of Table 3 where 100 analyses reflect the variations in chemical constituents and properties. Locations of the analyses are shown on Figure 15.

Wells producing water from the rock aquifers are mostly in the Piedmont area of the county—northwest of the Fall Line. There are, however, numerous wells that penetrate through the Coastal Plain units and obtain their water from the rocks underneath.

The most striking differences in water from the rock wells and sand wells are in pH, hardness, and total dissolved solids.

Table 2. Sand intervals on electric logs of wells in and near Richland County

County well number	S.C. grid number	Elevation, in feet MSL	Sand intervals, in feet below land surface
RIC-57	31P-b6	El. 250	45-90 BR at 116 450-570
RIC-58	26Q-x1	El. 162	110-285 300-360 360-435 425-545
RIC-63	26R-c1	El. 145	85-240 260-345 285-345 385-550 (br) BR at 640
RIC-294	26Q-q1	El. 170	75-120 130-190
RIC-297	30O-a1	El. 290	140-165 185-205
RIC-313	28P-n1	El. 330	168-215 250-270 435-560 595-625
RIC-348	26R-d1	El. 150	25-55 80-385 350-560
RIC-450	26Q-g1	El. 212	25-175 230-320
RIC-453	28O-n2	El. 410	65-190 225-245 255-295 (br)
RIC-473	27P-w2	El. 295	75-100 135-195
RIC-523	28O-y4	El. 280	20-85 95-140 210-230 260-300
RIC-525	30N-k1	El. 360	45-60 65-100
RIC-532	28P-q5	El. 235	30-100 140-210 (br) 225-270
RIC-533	28P-d1	El. 369	20-70 90-155 170-210 215-235 245-290
RIC-543	27Q-m1	El. 182	20-30 40-100 125-285 310-390 405-505 520-540 BR at 544
RIC-585	29P-t4	El. 320	15-19 33-50 56-70 80-86 92-172 206-218 232-248 266-277 310-319 330-340 346-352 368-393 409-429 435-440 446-455 BR at 455
RIC-612	28Q-s1	El. 150	12-53 66-72 80-101 112-130 174-246
RIC-613	29N-q2	El. 415	10-35 40-75 155-180 195-225 BR at 235
KER-140	28N-i1	El. 255	0-41 48-66 76-141 (br) BR at 165
SUM-156	25O-g1	El. 170	70-95 108-345 (br) BR at 345
SUM-310	26O-a2	El. 152	5-16 25-82 93-164 176-190 212-256
CAL-42	26S-o1	El. 226	10-68 73-88 106-155 180-300
CAL-56	31Q-v3	El. 215	18-87 160-280 (br) BR at 310
CAL-76	30R-i1	El. 340	15-40 125-150 175-308 (br)
CAL-83	29R-o2	El. 280	5-40 (br) 54-62 68-108 125-150 160-178 194-225
CAL-115	30R-g2	El. 180	15-75 80-102 110-138 (br) 150-340 (br)
CAL-132	31R-b1	El. 350	70-150 165-250 330-380 (br) 395-455 BR at 460

(br) — broken, meaning sand beds interrupted by clay layers. BR — bedrock. See Figure 13 for location of wells.

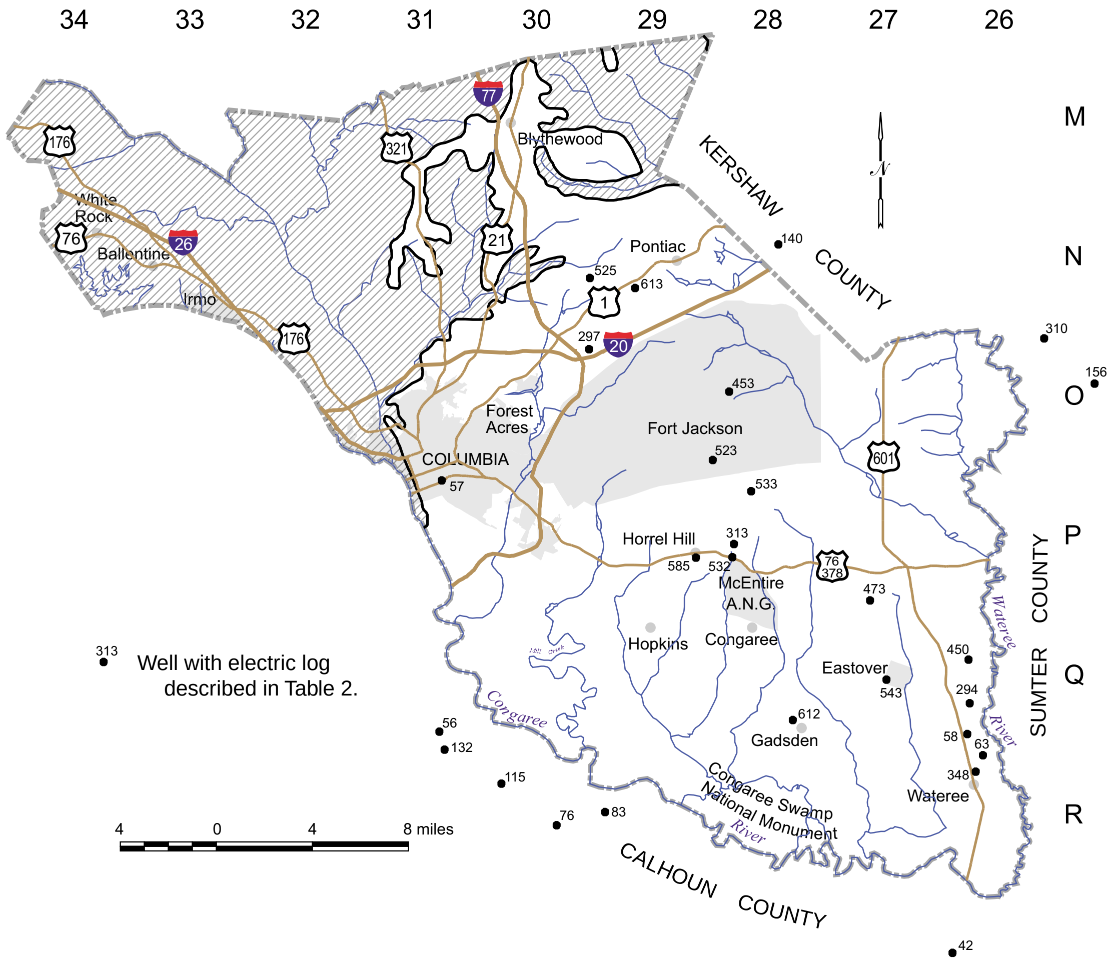


Figure 13. Locations of wells for which sand intervals are listed in Table 2.

The following table provides a summary of these differences.

	Rock wells	Sand wells
Number of analyses	37	63
pH > 7.0 (percentage of wells)	70	10
Median hardness (mg/L)	130	5
Median dissolved solids (mg/L)	250	30

It is obvious from the foregoing that water from the rock aquifers is likely to be alkaline, hard, and of moderate mineralization, whereas water from the sand aquifers is acidic, very soft, and very low in mineralization. Some other constituents are worthy of consideration when comparing the aquifers. Iron and manganese are considered excessive in drinking water if, together, they exceed 0.3 milligram per liter in concentration. Note that in Table 3 several wells in the rock aquifers show excessive manganese, and about the same number show excessive iron.

The reader is cautioned here to give the greater weight to the analyses of public-supply wells (in bold type), because they are the wells most likely to reflect water quality in the aquifer concerned. Some of the other analyses were made because of a natural or man-induced problem and, therefore, the results are skewed with regard to their representativeness. Iron is a common cause of unsuitable water, especially in the sand wells, where a combination of highly acidic water and undesirable pumping practices seems to favor the development of iron problems. The acidity is natural, of course, but pumping from levels below the top of the well screen, or even below the top of the aquifer, is the probable cause of high iron concentrations in the well discharge. The iron-producing bacterium *Crenothrix* has been named as a culprit that thrives in an aerated zone. Consequently, the well owner is advised to avoid installing his pump in the well screen.

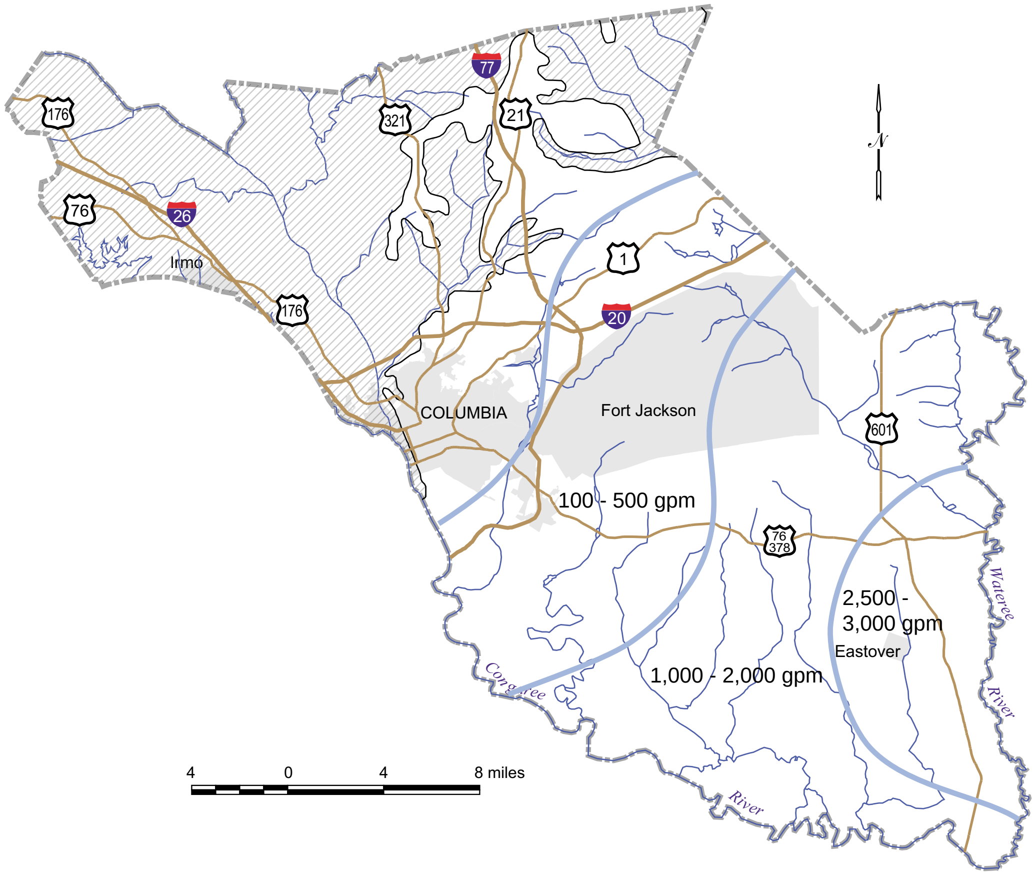


Figure 14. Distribution of maximum potential well yields from sand aquifers in Richland County.

An investigation currently in progress by the South Carolina Department of Health and Environmental Control is finding that numerous wells in the Inner Coastal Plain contain radionuclides, namely radium 226 and 228, in excess of the maximum contaminant level (MCL) promulgated by the U.S. Environmental Protection Agency (EPA). The area presently involves the counties from Aiken northeastward, including Lexington, Richland, Kershaw, and Lee Counties. In each of the last three named, two or three public-supply wells have been determined to have the high radium levels. Both sand wells and rock wells are involved. In Richland County, the only municipal water system using wells is the town of Eastover. High radionuclides have not been identified there.

Relatively high concentrations of radium in ground water in South Carolina have been recognized since 1982 or earlier. Radium and other radionuclides pose the risk of cancer and other toxic effects for some people who drink the high-radium water over many years. EPA has not raised the radium 226/228 MCL established in 1977 (5 picoCuries per liter), but it has instituted the requirement for testing individual wells in a public-supply system, not just a representative point in the system, as formerly.

Table 3. Chemical analyses of water from wells in Richland County (public-supply wells in bold type) (constituents are in milligrams per liter, essentially the same as parts per million)

County well number	S. C. grid number	Location	Date	Depth (ft)	Silica	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate*	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hardness	pH	Analyst**	
									ROCK WELLS											
82	**32N-q1**	**River Edge Subdiv.**	**9/80**	**240**		**0.1**					**84**		**25**				**51**	**6.4**	**DHEC**	
189	**31N-s1**	**Evergreen Park Housing**	**7/62**	**395**	**29**	**0.0**	**21**	**12**	**17**	**1.3**	**167**	**1.6**	**3.5**	**0.1**	**4.2**	**172**	**104**	**7.5**	**USGS**	
267	**33N-f1**	**I-26 nr U.S. 176**	**1/79**	**120**		**2.0**	**21**				**18**		**1**		**0.0**	**64**	**<10**	**5.6**	**DHEC**	
306	**32N-p1**	**Dutch Village Subdiv.**	**5/83**	**431**	**7.4**	**0.3**	**49**	**12**	**55**	**2.5**	**287**	**5.0**	**23**	**0.3**		**285**	**170**	**7.5**	**WRC**	
354	**31N-v2**	**Lincolnshire Subdiv.**	**7/71**	**354**		**0.3**	**8**	**11**			**132**		**3**			**144**	**64**	**7.5**	**DHEC**	
361	32M-k2	Cedar Creek Com.	8/78	110		3.4	163	47			179		300		0.0	1,600	560	6.8	DHEC	Manganese 2.4
362	31M-j1	Blythewood, 2 mi NW	1/82	125		<0.1					50		6			62	25	6.1	DHEC	
363	32M-k1	Cedar Creek Com.	8/78	200		0.1					194		45		0.2	270	120	7.2	DHEC	
364	32M-k3	Cedar Creek Com.	8/78	60		0.7					137		60		0.4	340	110	7.3	DHEC	
365	32M-l1	Cedar Creek Com.	8/78	120		<0.1					246		160		1.8	770	350	7.3	DHEC	
366	31M-k1	Blythewood, 3 mi W	10/75	84		0.2	116	38			432		195			890	446	7.2	DHEC	
367	32M-v1	Cedar Creek Com.	7/78	360							241		45			330		7.7	DHEC	
368	32M-t2	Cedar Creek Com.	8/78	350		<0.1					275		4		1.1	510	190	7.6	DHEC	
369	31M-q1	Nr. US 321 & Rd. 1682	8/78	106		<0.1					60		4		0.9	10	18	7.0	DHEC	
370	32M-s1	Cedar Creek Com.	3/78	245		<0.1					366		70		0.0	870	420	7.5	DHEC	
371	32M-s2	Cedar Creek Com.	8/78	373		0.1					196		45		0.5	260	130	7.6	DHEC	
372	32M-t1	Cedar Creek Com.	8/78	320		0.2					215		38		0.5	180	110	7.3	DHEC	
373	32N-f1	Ballentine, 5 mi ENE	7/81	160		<0.1							46			260	180	7.9	DHEC	Manganese 2.4
374	32N-f2	Ballentine, 5 mi ENE	12/81	165		<0.1					240		39			250	160	7.5	DHEC	
375	**33N-i1**	**Stonegate Subdiv.**	**8/80**	**400**		**0.5**					**108**		**42**			**320**	**180**	**7.4**	**DHEC**	
378	33N-f2	Ballentine, 1 mi N	12/76	120		0.6	40	2					4			188	108	7.1	DHEC	Manganese 1.0
379	31M-n1	Cedar Creek Com.	8/78	175		<0.1					329		210		0.0	1,200	390	7.2	DHEC	Manganese 0.4
380	32M-s3	Cedar Creek Com.	8/78	305		0.2					115		8		0.0	180	70	6.8	DHEC	
383	**30O-h1**	**Decker Blvd, nr U.S. 1**	**8/81**	**165**		**0.3**					**101**		**8**			**120**	**64**	**7.7**	**DHEC**	
385	31M-o1	Nr. US 321 & Rd. 59	8/78	52		8.0					110		60		0.0	390	160	6.8	DHEC	Manganese 2.3
386	**34N-m2**	**Lakeview Harbor Subdiv.**	**1/80**	**305**		**0.0**	**38**	**9**	**19**	**0.4**	**178**	**<1**	**8**	**0.0**	**0.2**	**219**	**131**	**7.6**	**COM**	
398	**30N-v5**	**Charleswood Subdiv.**	**6/77**	**580**		**0.6**					**109**		**18**		**0.1**	**150**	**58**	**7.2**	**DHEC**	
401	**32N-o1**	**Dutch Village Subdiv.**	**5/83**	**500**	**9.5**	**0.2**	**40**	**10**	**28**	**1.6**	**228**	**7.8**	**20**		**0.1**	**271**	**140**	**7.6**	**WRC**	
402	**32N-o2**	**Dutch Village Subdiv.**	**3/72**	**375**		**<0.1**	**31**	**7**					**16**			**206**	**66**	**6.1**	**DHEC**	
467	**32N-q3**	**River Edge Subdiv.**	**7/83**	**360**		**0.0**	**33**	**14**	**32**	**3.5**	**223**	**3.2**	**18**	**0.3**	**0.2**	**198**	**138**	**8.4**	**COM**	
468	**32N-q4**	**River Edge Subdiv.**	**8/83**	**260**			**15**	**5.8**	**22**	**3.1**	**82**	**<1**	**7**	**0.6**	**0.0**	**210**	**62**		**COM**	
477	34M-m1	Little Mountain	3/85	207	24	0.1	80	9.3	29	3.4	161	41	38	0.2	0.0	375	237	7.4	WRC	
520	29M-e1	Calico Farms Subdiv.	5/86	300		0.0	16	3.7	19	<10	128	<10	3.5	<0.3	<0.1	150	55	8.0	DHEC	
601	**34N-i3**	**White Rock**	**8/80**	**120**		**<0.1**	**40**				**148**		**75**		**0.3**	**340**	**130**	**6.8**	**DHEC**	
602	**34N-i4**	**White Rock**	**7/80**	**400**		**0.8**	**40**				**138**		**60**		**0.0**	**310**	**160**	**7.3**	**DHEC**	
603	**31O-k9**	**Bayberry Mews Subdiv.**	**2/96**	**360**		**<0.1**	**16**	**5**	**16**	**2.3**	**109**	**3.8**	**1.8**	**0.3**	**<5**	**130**	**60**	**8.0**	**COM**	
610	**34N-k2**	**White Rock**	**5/87**	**210**		**0.0**	**29**	**3.3**	**8.5**	**<10**		**10**	**9.5**	**<0.1**	**<0.8**	**110**	**86**	**6.5**	**DHEC**	

* Bicarbonate is calculated where alkalinity is reported.

** Analysts are COM, commercial; DHEC, Department of Health and Environmental Control; USGS, U.S. Geological Survey; and WRC, Water Resources Commission.

Table 3. (Continued)

County well number	S. C. grid number	Location	Date	Depth (ft)	Silica	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate*	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hardness	pH	Analyst**
									SAND WELLS										
4	28Q-d3	McEntire ANG Base	5/83	125	2.6	0.2	0.8	0.4	3.3	0.1		2.9	3.6	0.0		19	4	5.6	WRC
21	30O-w1	Ft. Jackson, nr Semmes	3/46	180		0.3					7.0	1.0	5.0	0.1	4.5		9		USGS
25	28Q-d1	McEntire ANG Base	3/46	160		0.3					5.0	1.0	3.5	0.1	3.2		10		USGS
48	28P-a1	McEntire ANG Base	5/83	164	2.6	0.1	0.3	0.3	1.9	0.1		3.1	4.2	0.0		12	2	5.1	WRC
52	27Q-13	Eastover	5/83	112	2.8		0.8	0.5	5.1	0.2	4.8		4.7	0.0		38	4	6.0	WRC
58	26Q-x1	Eastover, 4 mi SE	8/74	563	12	0.8	5.0	1.0	19		56		4.0			105	18	6.8	COM
63	26R-c1	Eastover, 5 mi SE	8/74	547	9.5	0.7	3.6	2.5	9.9		44	12	4.0			72	19	7.2	COM
74	29O-v1	Ft. Jackson ammo stor.	12/78	239		<0.1					4.0		1.0	<0.1	0.3	20	<10	5.4	DHEC
121	29N-l1	Pontiac, 1/4 mi NW	6/54	142			3.2	0.2			23	7.0	3.0		2.2	35	9	6.5	USGS
131	29P-l2	Horrell Hill, 1 1/2 mi NW	5/97	205	6.1	0.0	0.4	0.3	1.9	0.2	25	0.2	2.1	0.1	0.9	15	2	4.8	USGS
134	31P-i2	Nr USC stadium	6/56	85	8.3	0.0	5.2	2.4	6.1	4.1	5.0	0.0	3.5	0.0	42	93	24	5.7	USGS
137	29P-f1	VA Hosp. 21/2 mi E	8/56	30							4.0	1.0	1.5	0.0	1.0		2	5.3	USGS
143	29P-r2	Hopkins hwy, nr US 76	11/56	294	8.3	0.5	0.4	0.5	0.9	0.1	3.0	1.3	1.3	0.0	0.0	17	1	5.2	USGS
149	30O-g8	Shakespeare Road	3/59	260	7.1	0.1	0.5	0.3	14	0.2	6.0	21	4.0	0.0	2.2	54	2	5.6	USGS
150	30P-h6	Atlas Road	5/59	70			2.7	1.9			20	5.5	4.0		0.1		15	6.2	USGS
182	27O-w1	Ft. Jackson rifle range	11/78	200		0.4					1.2		4.0	0.0	0.2	30	<10	4.8	DHEC
188	30M-v2	Columbia CC	5/63	197	8.1	0.0	0.8	0.7	3.3	0.4	12	0.4	2.6	0.0	0.4	19	6	6.7	USGS
196	30P-h1	Nr. US 76 and SC 262	8/62	85	7.1	0.1	0.5	0.3	14	0.2	6.0	21	4.0	0.0	2.2	54	2	5.6	USGS
203	31P-i2	Univ. of S.C.	12/62	110	13	0.0	5.0	3.0	21	5.1	9.0	3.0	16	0.3	52	139	26	5.7	USGS
205	31P-j2	Nr Owens Field Airport	12/62	50	18	1.1	20	12	21	6.6	2.0	118	36	2.6	8.0	258	112	4.4	USGS
262	31O-v1	Senate and Bull Sts.	1/65	129	11	0.2	17	7.4	27	6.1	5.0	3.4	36	0.0	94	204	74	5.4	USGS
283	28Q-c1	Congaree, 1/2 mi ESE	5/83	127	2.6	0.2	0.5	0.4	2.7	0.1	1.2	2.8	4.7	0.0		41	3	5.3	WRC
294	26Q-q1	Eastover, 31/4mi ESE	12/68	532		2.5	3.6	1.0			38		8.0	0.4		70	13	7.1	COM
301	26Q-x2	Eastover, 4 mi SE	4/70	250	17	0.2	1.2	0.0			1.0	6.0	5.0	0.0		36	3	4.8	COM
302	29P-e1	Ft. Jackson, Twin Lakes	11/78	113		0.1					3.6		5.0	0.0	0.4		32	5.5	DHEC
305	28O-y2	Ft. Jackson, Weston Lake	5/83	310	2.6	0.2	3.4	0.2	0.8	0.1	23	3.1	2.6	0.0		83	9	6.9	WRC
308	30O-g1	Shakespeare Road	7/83	162	1.5						12		36				50	5.8	COM
348	26R-d1	Eastover, 5 1/4 mi SE	9/83	613	11	0.6	4.7	1.1	9.0	8.8	36	10	2.7	0.2		66	18	7.6	WRC
390	29P-w1	Hopkins, 1 mi N	2/69	118	8.0	0.2	9.6	3.9			6.1	0.0	0.0	0.0		40	40	4.2	USGS
394	30N-v1	Charleswood Subdiv.	8/80	104		0.1	9.0				157		3.5		0.0	140	40	7.9	DHEC
395	30N-v2	Charleswood Subdiv.	5/71	106		0.1	0.9	0.3			12		5.0			18	3	6.2	DHEC
396	30N-v3	Charleswood Subdiv.	7/72	106		0.1	1.1	0.3			7.2		7.0			34	4	5.7	DHEC
397	30N-v4	Charleswood Subdiv.	10/78	110		0.2					3.6		4.0		0.2			5.3	DHEC
399	30N-s1	Farrowwoods Subdiv.	1/72	100			1.6	0.4			14		1.0			50	6	7.3	DHEC
400	30N-s2	Farrowwoods Subdiv.	1/72	81		0.3	12	0.2			53		2.0			80	30	9.7	DHEC
403	30O-g6	Bella Vista Warehouses	2/80	92		0.1					1.8				2.6		2	5.1	COM
414	29O-o1	Ft. Jackson Algiers Well	12/78	105		<0.1					8.4		1.0	0.0	0.1	23	<10	6.0	DHEC
415	29O-i1	Ft. Jackson (Norm. Well)	12/78	120		<0.1					3.6		3.0	0.0		21	<10	5.7	DHEC
417	28O-y3	Ft. Jackson (Weston L.)	5/83	172	6.2	0.1	0.7	0.2	0.9	0.1	4.8	0.0	2.6	0.0		14	3	6.2	WRC
418	28O-n1	Ft. Jackson (Weston L.)	12/78	124		0.4							7.0	0.0	0.4		<10	5.8	DHEC

* Bicarbonate is calculated where alkalinity is reported.

** Analysts are COM, commercial; DHEC, Department of Health and Environmental Control; USGS, U.S. Geological Survey; and WRC, Water Resources Commission.

Table 3. (Continued)

County well number	S. C. grid number	Location	Date	Depth (ft)	Silica	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate*	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hardness	pH	Analyst**
		SAND WELLS (Continued)																	
420	**30N-r1**	**Washington Hts. Sub.**	**12/71**	**53**		**0.2**	**0.2**	**0.3**			**13**		**2.0**			**24**	**2**	**5.9**	**DHEC**
448	27Q-u1	Eastover, 3 mi SE	9/83	500	9.7	1.8	0.4	0.2	3.2	0.5	1.2	9.2	3.5	0.0		78	3	5.2	WRC
450	26Q-g1	Eastover, 3 mi E	11/82	604	6.0	0.5	0.3	0.0	8.0	3.3	3.7	14	10	0.0		43	1	5.0	COM
452	26Q-g2	Eastover, 3 mi E	7/82	584	12	0.8	0.5	0.1	1.6	1.6	13	18	4.0	0.0		44	2	4.4	COM
458	28Q-o1	Hopkins, 3 mi ESE	1/84	60	7.9	0.1	1.3	0.9	3.5	0.9	3.7	3.5	5.0	0.0		27	7	6.6	WRC
463	29O-e3	Springfield Acres Subdiv.	8/70	77		0.1	1.1	0.3			12		3.0			30	4	6.2	DHEC
487	30N-v7	Alpine Rd at US 1	9/85	150	7.1	0.3	1.5	0.2	13	0.5	38	7.0	7.6	0.0		49	4	6.1	WRC
502	**29N-h2**	**Rhame Rd nr Clem. Rds.**	**9/85**	**135**	**5.6**	**0.0**	**0.8**	**0.0**	**4.8**	**0.2**	**1.8**	**2.5**	**1.8**	**0.0**		**17**	**2**		**WRC**
504	30N-t1	Spring Valley Subdiv.	4/81	115		21					22		9.5			46	12	6.0	DHEC
506	29N-p1	Spring Valley Subdiv.	7/86	130	5.1	0.0	0.5	0.8	2.2	0.4	7.3	0.0	2.5	0.0		16	4	4.7	WRC
525	30N-k1	Spring Valley Subdiv.	1/90	100	1.3	0.0	0.2	0.3	3.1	0.5	0.6	0.4	4.0	0.0	0.8	9	2	4.6	WRC
531	29N-k1	Wood Creek Subdiv.	2/90	231		0.0	0.1	0.1	2.0	0.1	<20	<5	11	<0.1	<1	42	1	6.0	COM
566	30P-j1	Caughman & Leesburg Rd.	9/96	53	5.3	0.0	2.2	1.0	14	1.6	1.2	0.6	12	0.1	8.0	46	10	4.4	USGS
567	30P-i3	US 378-SC 262 juncture	9/96	47	7.7	0.0	1.3	0.1	1.3	0.1	4.9	1.0	1.8	0.1	0.2	16	4	5.1	USGS
568	29N-p9	Spring Valley Subdiv.	8/96	54	5.3	0.0	0.7	0.9	4.3	0.9	1.8	0.3	8.0	0.1	1.4	23	5	4.8	USGS
571	29P-f4	Downes Grove Rd.	8/96	52	6.3	0.0	3.3	0.7	3.1	1.7	1.8	4.1	6.1	0.1	2.0	28	11	4.9	USGS
581	30O-q3	Forest Acres (town)	11/96	50	12	1.1	0.4	1.4	1.6	1.6	11	1.4	2.2	0.1	0.1	27	7	4.4	USGS
584	30O-p4	Forest Acres (town)	9/96	51	6.4	0.1	1.7	1.2	4.5	1.0	1.3	0.2	6.2	0.1	3.3	25	9	4.7	USGS
586	26Q-g4	Eastover, 3 mi E	5/97	540	11	0.2	0.3	0.2	1.4	0.9	0.0	6.2	2.1	0.1	0.0	27	2	4.2	USGS
587	**30N-t9**	**Charleswood Subdiv.**	**4/97**	**93**	**5.1**	**0.1**	**0.6**	**0.4**	**2.4**	**0.2**	**27**	**1.2**	**4.2**	**0.1**	**0.3**	**28**	**3**	**4.5**	**USGS**
588	**28P-c2**	**Horrell Hill, 41/2 mi NE**	**6/97**	**290**	**6.0**	**0.0**	**0.4**	**0.3**	**1.4**	**0.2**	**2.2**	**0.2**	**2.2**	**0.1**	**0.5**	**14**	**2**	**4.7**	**USGS**
596	29N-r2	Sparkleberry Ln nr US 1	5/87	120		0.0	0.4	0.4	3.4	<10		<10	1.5	<0.1	1.3		2	5.7	DHEC
607	30P-e3	Nr VA Hospital	3/61	60	7.3	0.2	1.4	0.4	3.4	0.3	4.0	1.2	1.8	0.1	8.6	27	6	5.4	USGS
608	27P-m1	Eastover, 6 mi N	5/87	265		1.8	0.3	0.6	1.3	<10		13	2.0	0.1	0.0		3	5.5	DHEC
611	29P-j1	Horrell Hill, 1 1/2 mi N	5/87	136		0.0	0.3	0.2	0.9	<10		<10	1.0	<0.1	0.2		1	5.1	DHEC
641	28Q-f1	McEntire Base, 2 mi SW	8/02	252		0.0	0.4	0.2	1.0	0.4		<5		0.1	0.1	38	2	6.5	COM

* Bicarbonate is calculated where alkalinity is reported.

** Analysts are COM, commercial; DHEC, Department of Health and Environmental Control; USGS, U.S. Geological Survey; and WRC, Water Resources Commission.

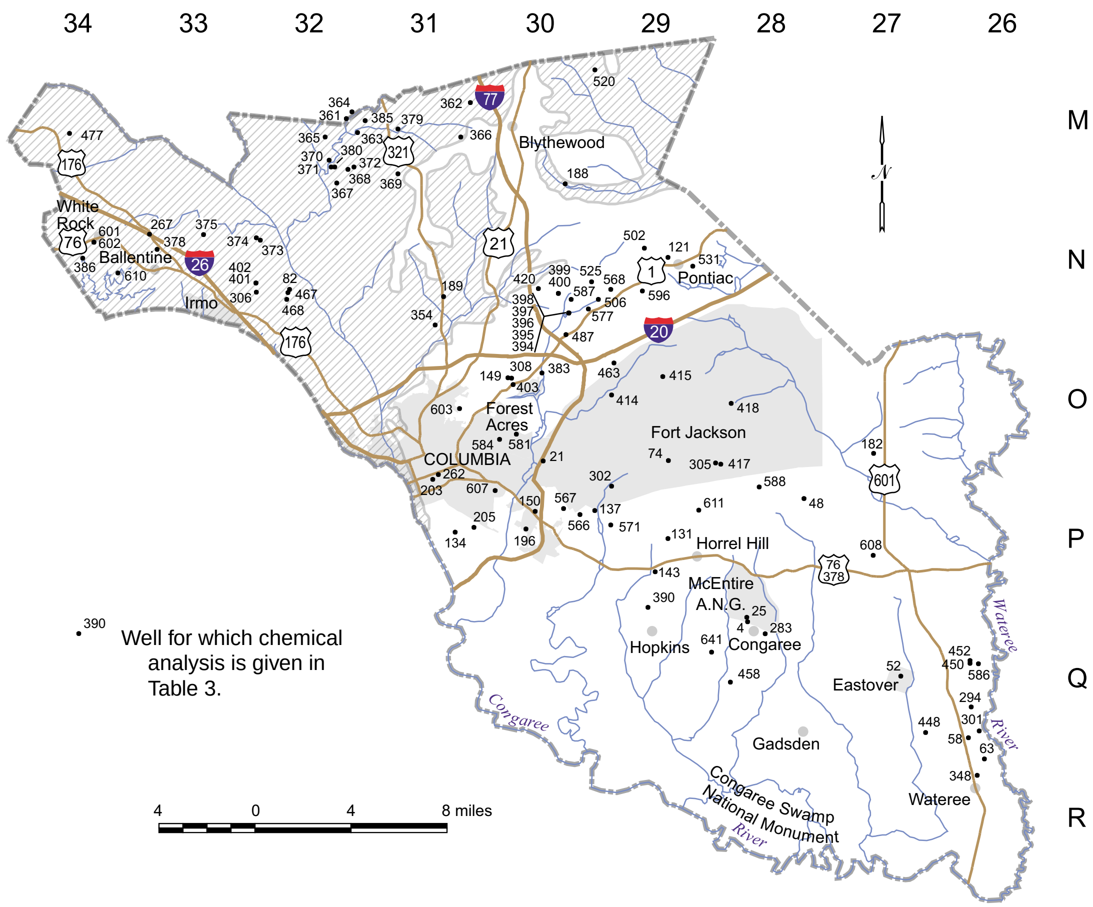


Figure 15. Locations of wells for which chemical analyses of the water are in Table 3.

SUMMARY

Richland County, in the "midlands" of South Carolina, is divided by the Fall Line into Piedmont and Coastal Plain geology. The northwestern third of the county is occupied by Paleozoic-age igneous and metamorphic bedrock, and the remainder by sand-and-clay formations of Cretaceous and Tertiary ages, with a minor amount of Quaternary terrace and alluvial material. The Coastal Plain formations thicken from 0 at the Fall Line to 650 ft in the county as they dip to the southeast and overlie the bedrock.

The hydrogeology of the bedrock differs markedly from that of the sand aquifers. Rock wells typically are a few hundred feet deep and produce water from cracks at unpredictable depths in the rocks. Their yields are usually low; half of them pump less than 10 gpm. Because wells are of 6-inch diameter and have shallow water levels, there is nearly always a substantial amount of well storage, so they are capable of furnishing, at least intermittently, a reliable supply. The water is alkaline, moderately mineralized, and hard.

Sand-aquifer wells usually are between 50 and 200 ft in depth, half of them less than 100 ft. They are equipped with well screens that range in diameter from 2 to 12 inches. Near the Fall Line, where the sand beds are shallow, the yields of wells are limited by thinness of sand and restricted available drawdown. In southern Richland County, however, wells 500-600 ft deep produce more than 2,000 gpm.

Pumping tests of wells in the sand aquifers have revealed transmissivity values from about 4,000 to 65,000 gpd/ft. The lowest values are in the area just below the Fall Line, and the highest are in the southern end of the county near Eastover and Wateree.

Deep water levels are common in the sand wells. In the Hopkins-Eastover area, the water levels are especially deep, more than 200 ft below the land surface in some wells. This has the effect of greatly restricting the yields of wells. One-fourth of the sand wells drilled in 2001-02 had water levels near or below the top of the producing sand bed. This is most noteworthy in the 150-300 ft depth range. Shallower and deeper aquifers generally have higher water levels.

The water, in contrast to that from rock wells, is acidic and very low in total mineralization and hardness; it is similar to rainwater.

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